

A new species and a new record of *Hypogastrura* (Collembola, Hypogastruridae) from Miguel Ángel Blanco shaft (Jaén, Spain)

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Abstract

A new species of cavernicolous Collembola belonging to the genus *Hypogastrura* Bourlet, 1839 from “Sima Miguel Ángel Blanco” (Jaén, Spain) is described: *Hypogastrura herrerosvelai* **sp. nov.** belongs to the *H. monticola* group of species within the genus and is easy to distinguish from its three relatives, *Hypogastrura monticola* Stach, 1946, *H. hispanica* Steiner, 1955 and *H. dasiensis* Selga, 1966, by the dorsal chaetotaxy. On the other hand, the presence of the species *Hypogastrura socialis* (Uzel, 1890) in the Iberian Peninsula is confirmed.

Keywords

Arthropoda, biospeleology, Hypogastruridae, *Hypogastrura herrerosvelai* sp. nov., *Hypogastrura socialis*, taxonomy

Introduction

The genus *Hypogastrura* Bourlet, 1839 is a widespread and highly diverse Collembola genus. A total of 170 species are currently known (Bellinger et al. 1996–2020), in which 19 in Spain (Jordana et al. 1997; Deharveng and Fjellberg 2013) although there are no *Hypogastrura* records in Andalusian caves. They have been divided into

some species groups based on morphology by Yosii (1960), Christiansen and Bellinger (1980), Babenko et al. (1994) and Thibaud et al. (2004). Presently, seven groups are used in the taxonomy of the genus: *crassaegranulata*, *manubrialis*, *monticola*, *sahlbergi/packardi*, *socialis/nivicola*, *trybomi*, and *viatica* (Skarżyński 2009).

In the course of our study of cavernicolous Collembola from Jaén (Andalucía, Spain), we discovered one new species of *Hypogastrura* belonging to the *H. monticola* group as well as specimens of *Hypogastrura socialis* (Uzel, 1890), so that the presence of this species in the Iberian Peninsula is confirmed. A description of the former species and a descriptive note on the taxonomic status of the latter are given. The present paper expands the known Hypogastruridae diversity of Andalusian caves by adding one newly recorded genus and two species.

Material and methods

Study area

The shaft “Miguel Ángel Blanco” is located in the “Morrón del Cerezo” peak, Sierra de las Villas, municipality of Villacarrillo, in Jaén province (Spain) (Fig. 1A). The entrance is located at 1377 m a.s.l. coordinates 38°03'43.02"N, 2°54'19.85"W. This area is characterized by the intercalation of dolomites and limestones from the Jurassic Period (Lías-Dogger), together with green clays from the Cretaceous (Fig. 2A) (Pérez Fernández and Pérez Ruiz 2014). It has got a small entrance and only one well with -20 metres depth, that makes a total development of -30 metres (Fig. 1B). The verticality of this cavity and the continuous precipitation throughout the year, results in a very active level of geological formations (Pérez Fernández and Pérez Ruiz 2014). The bottom of that well has got a lot of stones from the exterior as well as organic materials. In this part of the cavity pitfall traps were applied to capture the springtails mentioned in this paper (Fig. 2B).

Preparation and analysis

Specimens were cleared in Nesbitt's fluid, subsequently mounted on slides in Hoyer's medium for compound microscope observation in phase contrast. Figures were drawn with a camera lucida.

Terminology

The terminology for the description follows that given in Christiansen and Bellinger (1980), Fjellberg (1984, 1999), Jordana et al. (1997) and Thibaud et al. (2004).

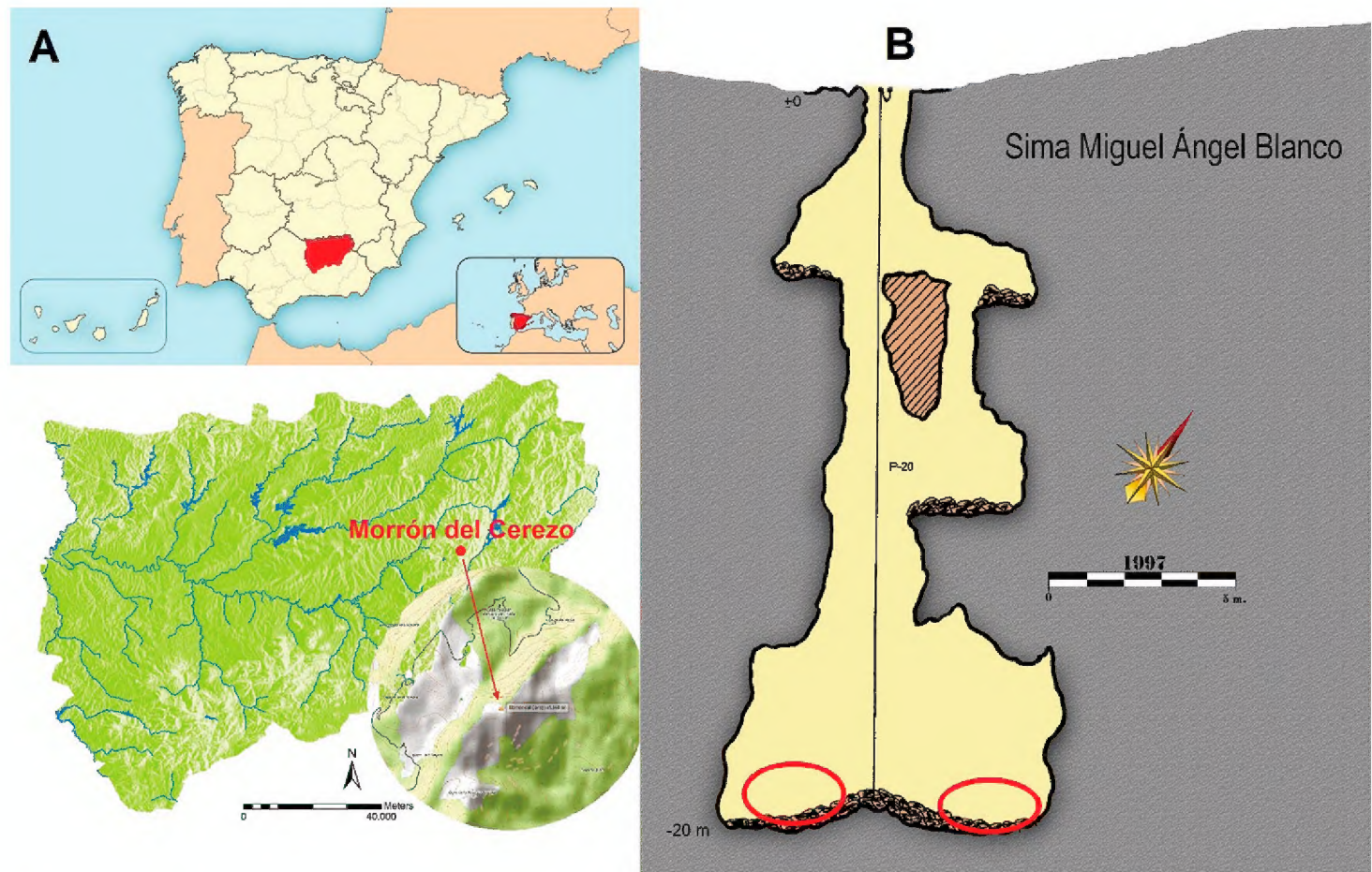


Figure 1. “Miguel Ángel Blanco” shaft **A** location map of Morrón del Cerezo peak, Sierra de las Villas, where the shaft is located **B** shaft profile, and location of the pitfall traps at -20 m bgl (after G.E.V.).

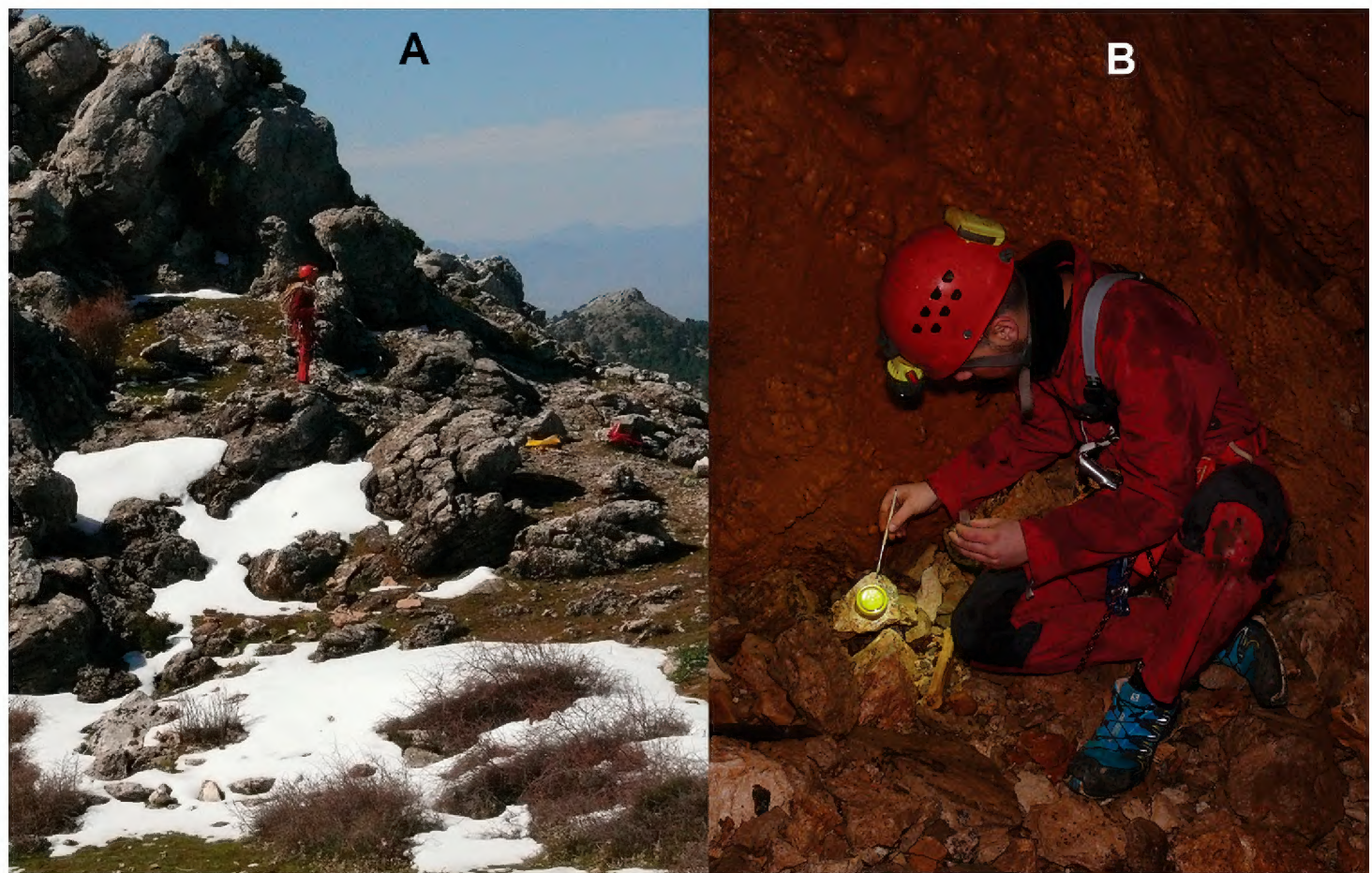


Figure 2. “Miguel Ángel Blanco” shaft **A** environment in the Sierra de las Villas karst (Photo by G.E.V.) **B** sampling work in the shaft (Photo by G.E.V.).

Abbreviations used: a row, m row, or p row = anterior, mid, or posterior row of body dorsal chaetae; Abd. I–VI = abdominal terga I–VI; Ant. I–IV = antennal segments I–IV; PAO = postantennal organ; s = sensory chaeta/sensillum; Th. I–III = thoracic terga I–III; G.E.V. = Speleological Club of Villacarrillo; MNCN = National Museum of Natural Sciences at Madrid, Spain.

Results

Family Hypogastruridae Börner, 1906

Genus *Hypogastrura* Bourlet, 1839

Hypogastrura herrerosvelai sp. nov.

<http://zoobank.org/F219FD66-C556-4898-B1CD-79826906CEC5>

Figs 3, 4

Type locality. Spain, Jaén: Sierra de las Villas karst of Villacarrillo, Sima Miguel Ángel Blanco, 38°03'43.02"N, 2°54'19.85"W, 1377 m elevation.

Type material. Holotype female mounted on slide: Spain, Jaén, Villacarrillo, Sierra de las Villas karst, Sima Miguel Ángel Blanco, 13 April 2019, G.E.V. leg. Paratypes: 1 male and 11 females mounted on slides, same data as for holotype. Holotype and paratypes deposited in MNCN.

Etymology. Dedicated to our colleague Alfonso Carlos Herreros Vela, founding partner of the Villacarrillo Speleology Group (G.E.V.).

Distribution. This species is known only from the type locality.

Description. Body length (excluding antennae) of adults: holotype 1.0 mm, male 1.1 mm, females 0.9–1.3 mm. Habitus typical of genus. Color dark bluish-black, paler ventrally, eye-patches dark. Granulation fine and uniform, 7–10 granules between chaetae p1 on Abd. V (Fig. 4F).

Ant. IV with simple apical vesicle, subapical organite (or), microsensillum (ms), two lateral and three dorsal long thin and curved blunt sensilla (S7, S8 + S1, S2, S3 in Fig. 4A). Ant. III-organ with two long (outer) and two short (inner) sensilla (Fig. 4A). Microsensillum on Ant. III present. Ant. I with eight chaetae (chaeta p' present).

Ocelli 8 + 8. Postantennal organ 1.5–1.8 larger than neighboring ocellus, with four subequal lobes of which anterior pair larger than posterior one. Accessory boss present (Fig. 4B). Labrum with four distinct apical papillae (Fig. 4E). Labral chaetae 5, 5, 4, prelabrals 4. Maxillary head of the *H. tullbergi* type (Fjellberg 1984) and labium as in Fjellberg (1999) (Fig. 4C). Outer lobe of maxilla with two sublobal hairs (Fig. 4D).

Tibiotarsi I, II, III with 19, 19, 18 chaetae respectively. Apical chaeta A1 long pointed or blunt. Claws with small inner tooth. Empodial appendage with broad basal lamella and apical filament reaching slightly beyond inner tooth of unguis (Fig. 4J).

Chaetotaxy of head typical of genus, with complete set of v-chaetae (Fig. 3A). Chaetae short and smooth. Body sensilla (s) about two times longer than ordinary chaetae, fine and smooth. Dorsal chaetotaxy as in Fig. 3A, B. Th. I with 3 + 3 chaetae.

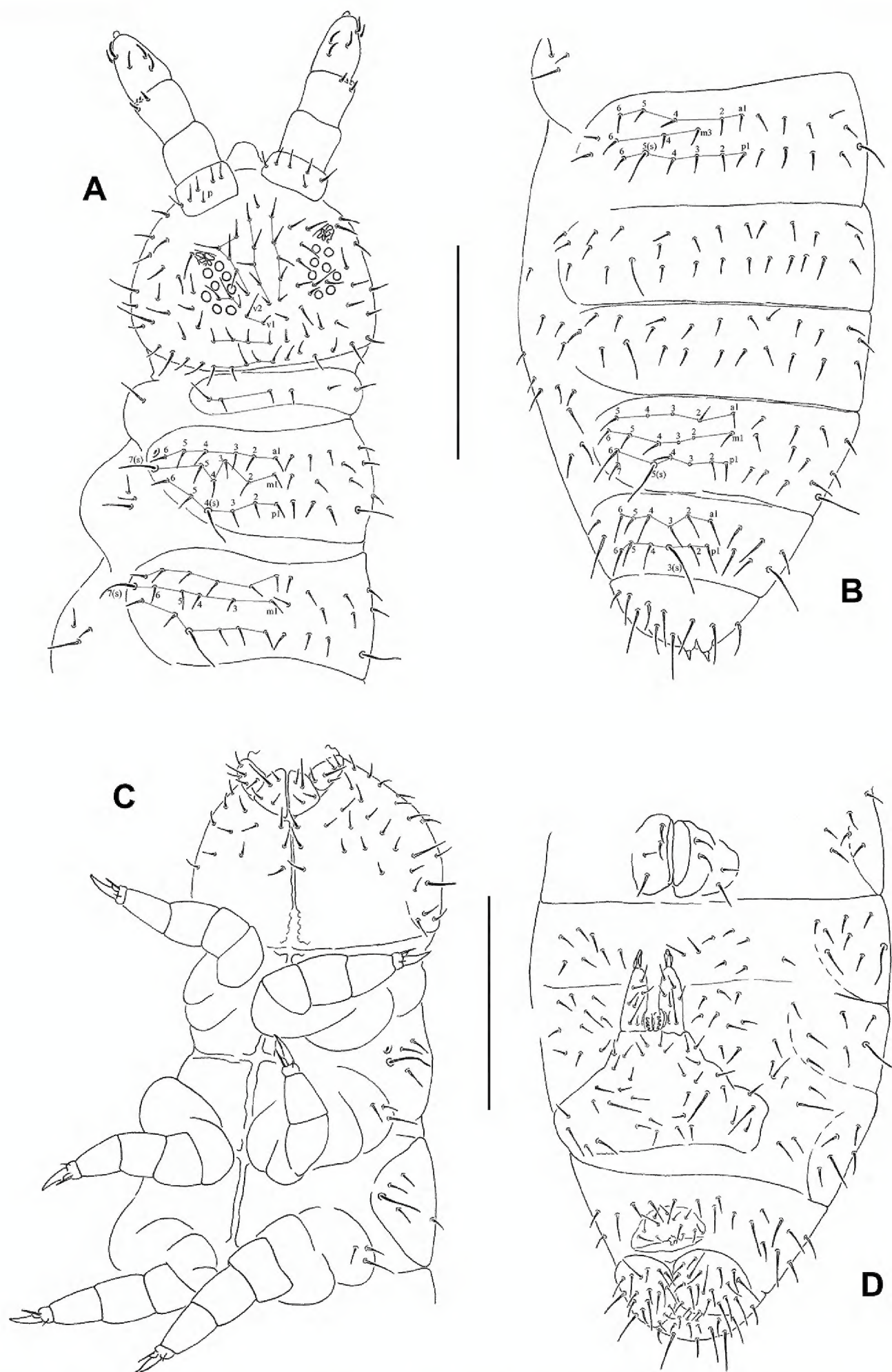


Figure 3. *Hypogastrura herrerosvelai* sp. nov **A,B** dorsal chaetotaxy **C,D** ventral chaetotaxy. Scale: 0.2 mm.

Th. II with chaetae m2, m3, m4 and m5 present, m6' and m6 absent. Th. III with chaetae m3, m4 and m5 present, m2 and m6' absent and chaeta m6 usually absent (rarely present). Abd. IV with chaetae p3 and p7 present, and with chaetae m1 to m6

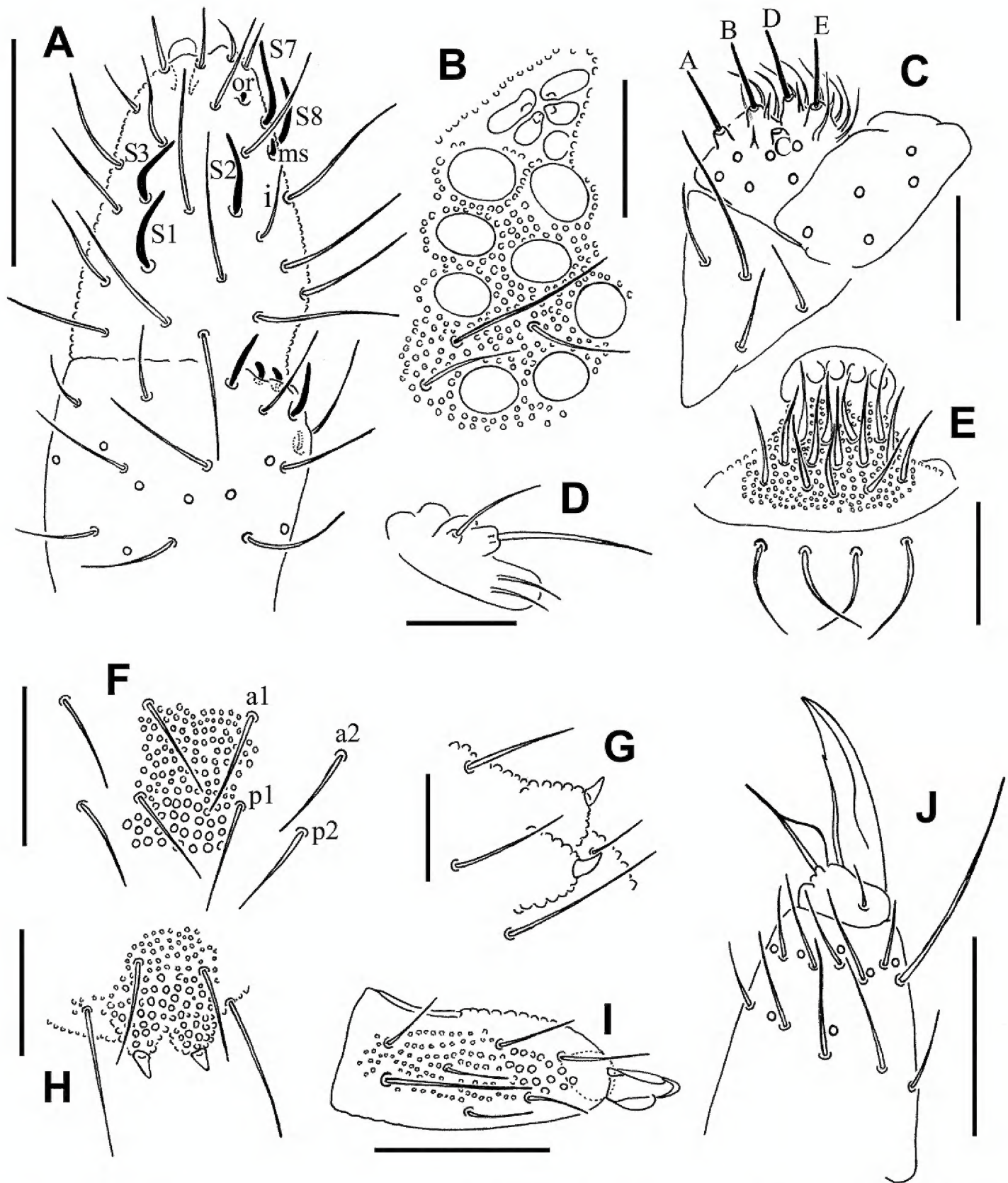


Figure 4. *Hypogastrura herrerosvelai* sp. nov. **A** ant. III-IV chaetotaxy **B** PAO and eyes **C** labium (**A-E** labial papillae) **D** maxillary palp **E** labrum **F** axial chaetotaxy and granulation on Abd. V **G, H** anal spines in lateral (**G**) and dorsal (**H**) view **I** Dens and mucro **J** Tibiotarsus and claw III. Scales: 0.03 mm (10, 12, 14–19), 0.02 mm (11, 13).

present. On Abd. V chaetae p2 present (2+2 chaetae between s-chaetae) and m-chaetae absent. Subcoxae1 of legs I, II, III with 1, 3, 3 chaetae respectively. Microsensillum on Th. II present.

Ventral chaetotaxy as in Fig. 3C, D. Ventral tube with four chaetae on each side. Retinaculum with 4 + 4 teeth.

Furca well developed (ratio dens+mucro/inner edge of claw III 2.5–3.5). Dens without tooth-like granules and ventro-apical swelling. Dorsal side of dens with fine granulation (the granules become enlarged towards apex) and seven chaetae. Mucro with relatively high outer lamella. Ratio dens/mucro 3.5–4.5 (Fig. 4I).

Anal spines small, situated on high basal papillae (Fig. 4G, H), ratio anal spine/basal papilla 0.5–0.7, ratio anal spine+basal papilla/inner edge of claw III 0.9–1.0.

Hypogastrura socialis (Uzel, 1890)

Figs 5, 6

Material examined. Spain, Jaén: Villacarrillo, Sierra de las Villas karst, Sima Miguel Ángel Blanco, 13 April 2019, G.E.V. leg. 15 females and three males mounted on slides.

Description. Body length (excluding antennae) of adults 1.1–1.5 mm. Habitus typical of the genus. Color dark bluish-black, paler ventrally, eye-patches dark. Granulation fine and uniform, 6–8 granules between chaetae p1 on Abd. V (Fig. 6K).

Ant. IV with simple apical vesicle, subapical organite (or), microsensillum (ms), (6)–8–(9) lateral and three dorsal curved blunt sensilla (S7, S8, S9, 3–6 S9' + S1, S2, S3 in Fig. 6A–H). Ant. III-organ with two long (outer) and two short (inner) sensilla (Fig. 6A). Microsensillum on Ant. III present. Ant. I with eight chaetae (chaeta p' present).

Ocelli 8 + 8. Postantennal organ slightly shorter than neighboring ocellus, with four subequal lobes; accessory boss present (Fig. 6I). Labrum with four distinct apical papillae (Fig. 6J). Labral chaetae 5, 5, 4, prelabrals 4. Maxillary head of the *H. tullbergi* type (Fjellberg 1984) and labium as in Fjellberg (1999). Outer lobe of maxilla with two sublobal hairs.

Tibiotarsi I, II, III with 19, 19, 18 chaetae respectively. Apical chaeta A1 long clavate. Claws with small inner tooth. Empodial appendage with broad basal lamella and apical filament not reaching the inner tooth of unguis; ratio empodial appendage/inner edge of claw about 0.5 (Fig. 6O).

Chaetotaxy of head typical of the genus, with complete set of v-chaetae (Fig. 5A). Chaetae short and smooth. Body sensilla (s) about 1.5 times longer than ordinary chaetae, fine and smooth. Dorsal chaetotaxy as in Fig. 5A, B. Th. I with 3 + 3 chaetae. Th. II with chaetae m1–6' present, m6 absent. Th. III with chaetae m1, m3–6' present, m2 and m6 absent. Abd. IV with chaetae p1–7 present, and with chaetae m1–5 present. On Abd. V chaetae p2 present (2+2 chaetae between s-chaetae) and m-chaetae absent. Subcoxae I, II, III with 1, 3(4), 3 chaetae respectively. Microsensillum on Th. II present.

Ventral chaetotaxy as in Fig. 5C, D. Ventral tube with five chaetae on each side. Retinaculum with 4 + 4 teeth.

Furca well developed (ratio dens+mucro/inner edge of claws III 2.7–3.1). Dens with tooth-like granules and ventro-apical swelling, and seven chaetae. Mucro with relatively high outer lamella. Ratio dens/mucro 2.9–3.3 (Fig. 6M, N).

Anal spines small, situated on low basal papillae (Fig. 6L), ratio anal spine/basal papilla 1.5–2.0, ratio anal spine+basal papilla/inner edge of claw III 0.3–0.4.

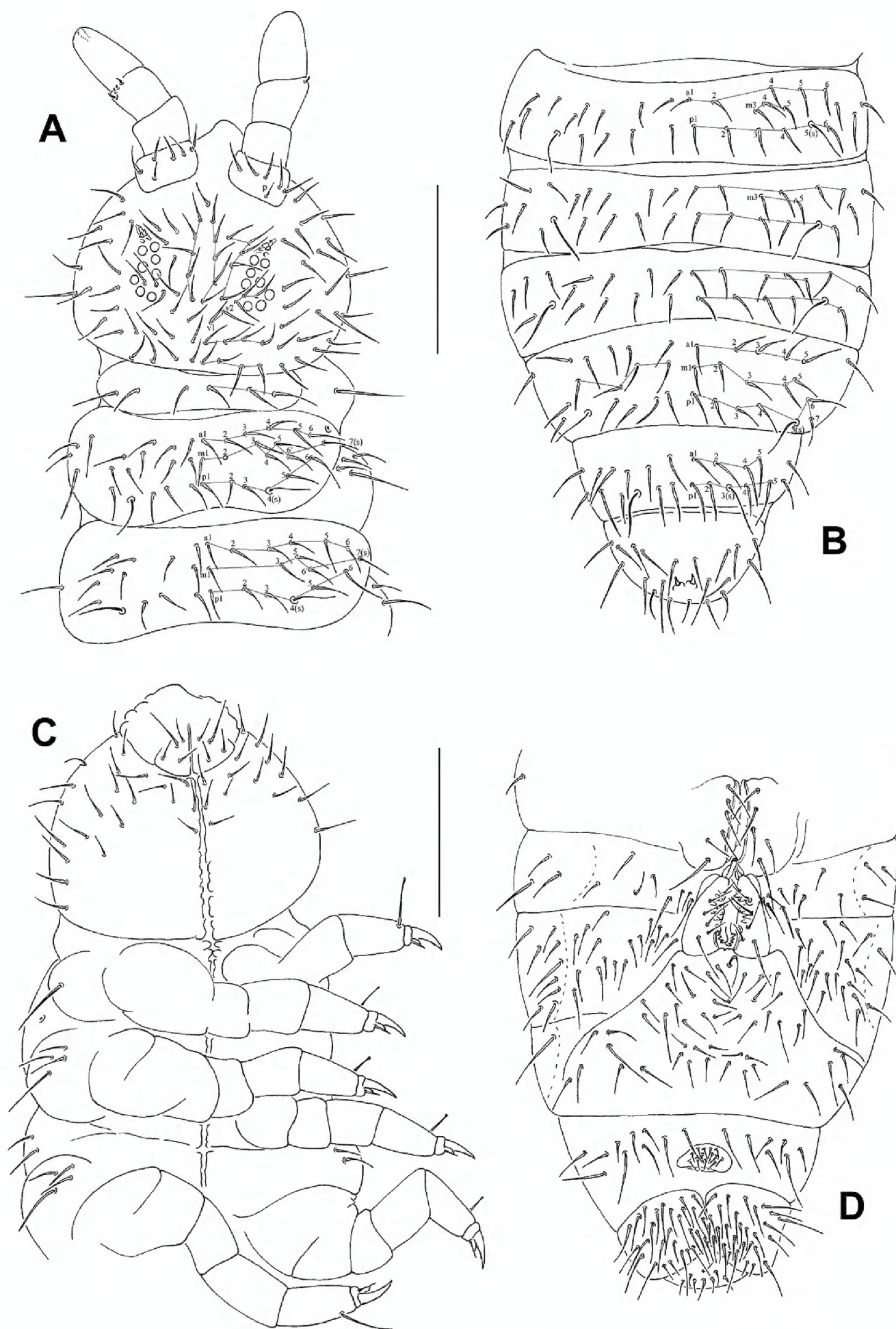


Figure 5. *Hypogastrura socialis* **A, B** dorsal chaetotaxy **C, D** ventral chaetotaxy. Scale: 0.2 mm.

Taxonomic note. The specimens from Jaen fits the description of *H. socialis* sensu Stach (1949), Babenko et al. (1994), and Fjellberg (1998). *H. socialis* sensu Jordana (1980) and Jordana et al. (1997) (winter form from Quinto Real, West

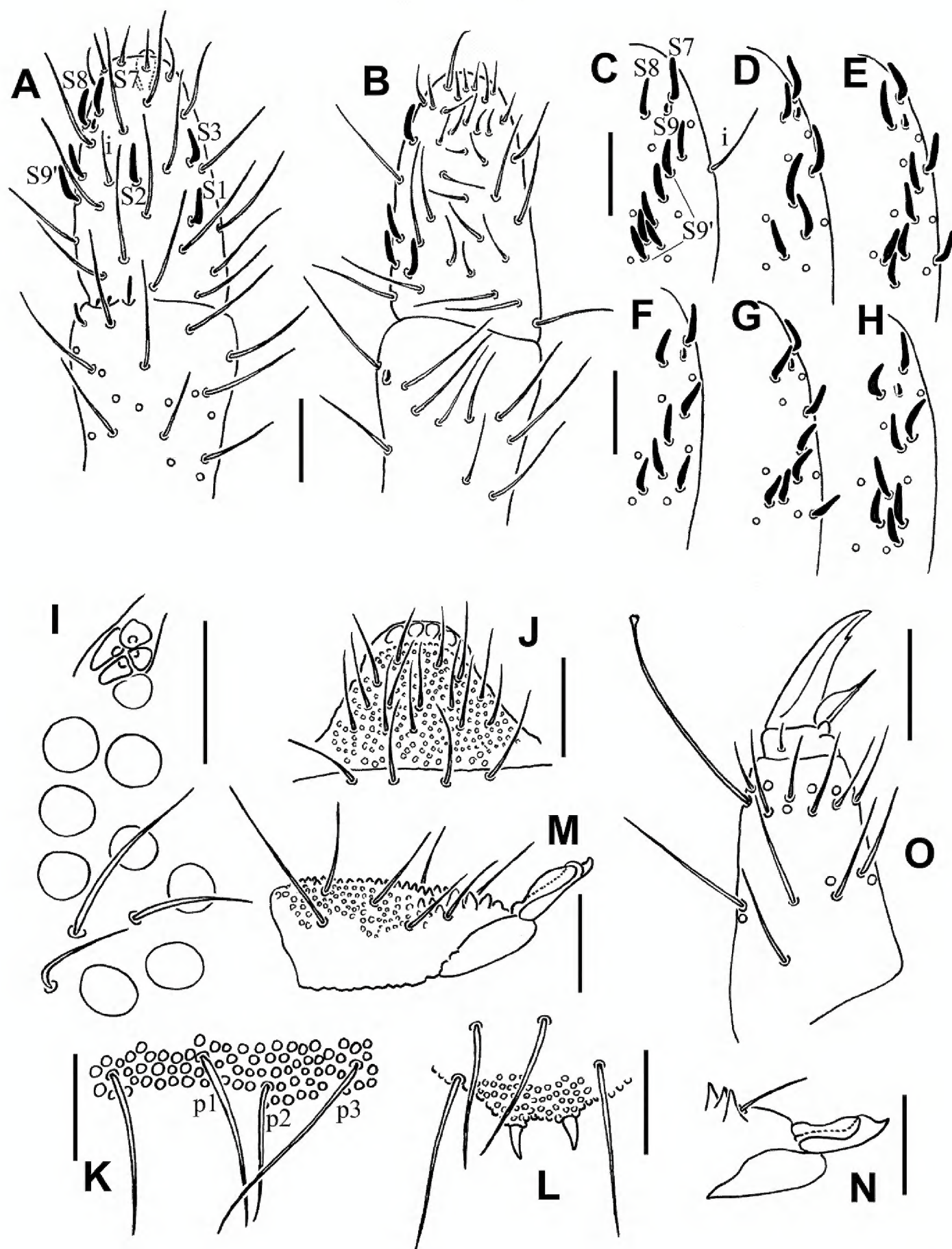


Figure 6. *Hypogastrura socialis* **A, B** ant. III-IV chaetotaxy in dorsal (**A**) and ventral (**B**) view **C-H** outer sensilla in different specimens **I** PAO and eyes **J** labrum **K** axial chaetotaxy and granulation on Abd. V **L** anal spines **M, N** dens and mucro **O** tibiotarsus and claw III. Scale: 0.03 mm.

Pyrenees) in fact represents a species different from *H. socialis* (see Skarżyński and Kaprus' 2009). They differs by the number of sensilla on Ant. IV and the dorsal chaetotaxy (see Table 2).

Table 1. Morphological differences between *Hypogastrura herberosvelai* sp. nov and the palaearctic members of the *monticola* group. Abbreviations: A5G = Abd. V granulation, number of granules between p1 chaetae (F = fine, C = coarse); DG = Dens granulation (F = fine, C = coarse); SIV = Number of sensilla on Ant. IV, dorsal+outer; TH = Tenent hairs on tibiotarsi (tips: P = pointed, B = blunt, C = clavate); VT = Number of chaetae on ventral tube; D/M = Ratio dens:mucro; As/P = Ratio anal spine/basal papilla; m6T2 = Th. II m6 chaeta; m6T3 = Th. III m6 chaeta (“+” = present, “–” = absent); mA4 = Abd. IV m chaetae; mA5 = number of m chaetae on Abd. V; pA5 = number of p chaetae between sensory chaetae on Abd V. References: od = original description; 1 = Babenko et al. 1994; 2 = Cassagnau 1959; 3 = Gisin 1949; 4 = Jordana et al. 1997; 5 = Selga 1966; 6 = Skarżyński 2009; 7 = Stach 1946; 8 = Steiner 1955; 9 = Thibaud et al. 2004; 10 = own data.

	A5G	DG	SIV	TH	VT	D/M	As/P	m6T2	m6T3	mA4	mA5	pA5	Length	Distribution	References
<i>monticola</i>	F	F	3+2	P	4+4	4–5	1	+	?	11+11	3+3	2+2	1.5	Central Europe	7(od)
<i>papillata</i>	F	M	3+3	B/P	4+4	3	0.5	+	?	m1, 2, pluri- 5+5	m1, 4, 5 4+4	2+2	1.1	Europe meridional	1, 6, 9
<i>papillata</i> sensu Jordana	F	M	3+3	B	4+4	3	0.5	–	–	m1–5 5+5	m1, 2, 4, 5 1+1	2+2	?	Portugal	3(od) 1, 9
<i>hispanica</i>	F	F	3+2	C	5+5	3	1	+	+	m1–5 6+6	m3 2+2	3+3	1.4	Spain	4
<i>dasiensis</i>	C	F/M	3+2	C	4+4	3–4	1	+	+	m1–6 5+5	m1,3 2+2	2+2	1.5	Spain	8(od) 4, 9
<i>subpapillata</i>	C	C	3+3	B/P	4+4	3	<1	+	+	m1, 2, 4–6 6+6	m1,3 2	2+2	1.0	Russia, Siberia	5(od) 4, 9
<i>batipanae</i>	C	F	3+3	C	4+4	3	1*	+	+	m1–6 6+6	m1, 2 1+1	2+2	1.0–1.1	Caucasus	1(od) 9
<i>elevata</i>	C	F	3+3(4)	P	4+4	3–4	1	?	?	m1–6 ?	m1 ?	?	0.9–1.0	France, Pyrenees	2(od) 6, 9
<i>herberosvelai</i> sp. nov.	F	F	3+2	P/B	4+4	4–5	<1	–	–(+)	6+6 m1–6	–	2+2	1.0–1.3	Spain	10(od)

Table 2. Morphological differences between the palaeartic members of the *socialis/nivicola* group. Abbreviations: A5G = Abd. V granulation, number of granules between p1 chaetae (F = fine, C = coarse); DG = Dens granulation (F = fine, C = coarse, T = Triangular humps); SIV = Number of sensilla on Ant. IV, dorsal+outer; pI = p chaeta on Ant. I (“+” = present, “-” = absent); TH = Tenent hairs on tibiotarsi (L = long, S = short); VT = Number of chaetae on ventral tube; D/M = Ratio dens:mucro; T1 = Number of chaetae on Th. I; mT2 = Th. II m chaetae; mT3 = Th. III m chaetae; mA4 = Number of p chaetae between sensory chaetae on Abd IV; pA5 = Number of p chaetae between sensory chaetae on Abd V; References: od = original description; 1 = Axelson 1902; 2 = Babenko et al. 1994; 3 = Dallai and Ferrari 1971; 4 = Danyi 2013; 5 = Fjellberg 1985; 6 = Fjellberg 1998; 7 = Gisin 1960; 8 = Jordana 1980; 9 = Jordana et al. 1997; 10 = Latzel 1917; 11 = Lee 1974; 12 = Peja 1985; 13 = Skarzynski and Smolis 2003; 14 = Steiner 1959; 15 = Tamura 1997; 16 = Thibaud et al. 2004; 17 = Uzel 1890; 18 = Yosii 1960; 19 = Yosii 1961; 20 = Own data.

	A5G	DG	SIV	pI	TH	VT	D/M	T1	mT2	mT3	mA4	pA4	pA5	Length	Distribution	References
<i>bokusi</i>	?	T	3+3	?	1L	4+4	2	3+3	3+3	?	5+5	4+4	2+2	1.4	Japan	19(od)
<i>calceolaris</i>	?	T	3+4-5	?	1L+6-7S	?	3-4	?	?	?	m1, 2, 3, 4, 5	?	?	1.5	Austria	16
<i>janetscheki</i>	F	F	3+5	+	1L	5+5	3-3,5	3+3	5+5	4+4	4+4	4+4	2+2	1-1.5	Spain, Ukraine	14(od)
<i>kelmendica</i>	C	T	3+4	+	1L	4-5+4-5	4	2+2	m1, 3, 4, 5, 6'	m1, 3, 5, 6'	m1, 3, 4, 5	3+3	1+1	0.9	Albania, Croatia, Poland	9
<i>lapponica</i>	C	T	3+4 (3-5)	+	1L+5S	4+4	4-5	3+3	m1, 3, 5	m1, 3, 5	m5	4+4	1+1	1.5-1.7	Palaeartic	12(od)
<i>meridionalis</i>	F	T	3+3	+	1L	4+4	2-3	3+3	m1, 2, 3, 4, 5	m1, 2, 3, 5	m1, 3, 4, 5	3+3	2+2	1.8	Spain, Italy	13, 16
<i>nemorialis</i>	F	C	3+5	?	1L	5+5	3	3+3	m1, 2, 3, 5, 6	m1, 2, 3, 5, 6	m1, 3, 4, 5	4+4	2+2	1.8	Japan, Korea	1(od)
<i>peloponnesica</i>	F	C	3+3	+	1L	4+4	3-4	3+3	4+4	?	m1, 3, 4, 5	4+4	2+2	1-1.8	Greece	2, 5, 16
<i>socialis</i>	10-11	T	3+8 (6-9)	+	1L	5+5 (3-7)	3-4	3+3	m1, 2, 3, 4, 5, 6	m1, 2, 3, 5, 6	m1, 3, 4, 5	4+4	2+2	1.1-1.5	Palaeartic	14(od)
<i>socialis</i> sensu Dallai and Ferrari 1971	7-10	T	3+5					2+2	m1, 2, 3, 4, 5, 6', (6)	m1, 3, 5, (6')	m1, 2, 3, 4, 5	3+3(4)	1+1	?	Italy	9, 16
<i>socialis</i> sensu Jordana 1980	F	T	3+4-5	+	1L	5+5	4-4,5	3+3	m1, 3, 4, 5	m1, 3, 5	m3, 5	4+4	1+1	0.9-1.1	Spain	18(od)
<i>spei</i>	F	T	3+5 (4-6)	+	1L	5+5	3-4	?	m1, 2, 3, 5, 6'	m1, 2, 3, 5, 6'	m3, 4, 5	4+4	1+1(2)	1.3	Russia, Armenia	2, 6, 16, 20
<i>tooliki</i>	F	T	3+3-4	+	1L	5+5 (4-6)	3	?	m1, 2, 3, 4, 5, 6'	m1, 2, 3, 5, 6'	m1, 2, 3, 4, 5	4+4	2+2	1.5	Russia, Alaska	3
<i>tsukubaensis</i>	F	T	3+6	-	1L	5+5	3	2+2	?	?	m1, 3, 4, 5	4+4	2+2	1-1.3	Japan	5(od)
<i>yongmuensis</i>	F	C	3+7	?	1L	5+5	3-4	3+3	1, 2, 3, 4, 5	m1, 2, 3, 5	m1, 4, 5, 6	4+4	2+2	1-1.1	Korea	16
	?								4+4	4+4	5+5	4+4	2+2			11(od)
									1, 3, 5, 6'	m1, 3, 5, 6'	m1, 2, 3, 4, 5					16

Discussion

The following features place the new species in the *monticola* group (Skarżyński 2009): Ant. IV with weakly differentiated sensilla arranged in two groups: 3 dorsal and 2 lateral, PAO 1.5–2 times larger than the adjacent ocelli, labrum with papillae, empodial appendage with a broad basal lamella, tibiotarsi with one tenent hair, retinaculum with 4+4 teeth, dens with 7 chaetae and without tooth-like granules and ventro-apical swelling, mucro without distinct subapical tooth and ventral tube with 4+4 chaetae. From among the members of this group *Hypogastrura monticola* Stach, 1946, *H. hispanica* Steiner, 1955 and *H. dasiensis* Selga, 1966 seem to be most similar to *H. herrerosvelai* sp. nov. by the sensillar chaetotaxy on Ant. IV (3+2 sensilla) and fine cuticular granulation on dens, but they differ in the dorsal chaetotaxy (m6 chaeta on Th. II absent in the new species vs m6 present in the other species; m-chaetae absent on Abd V in the new species vs 2+2 or 3+3 m chaetae in the other species). The main diagnostic features of the new species which distinguish it from other members of the *H. monticola* group are summarized in Table 1.

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